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Two New Genera of Hydrobiid Snails (Prosobranchia: Rissooidea) from the Northwestern United States

by

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Abstract. Based on morphological study of recently collected material, *Bythinella hemphilli,* distributed within the lower Snake-Columbia River basin, is transferred to a new genus, ***Pristinicola***; and ***Taylorconcha serpenticola,*** new genus and new species, a federally listed taxon restricted to a short reach of the Middle Snake River in Idaho and previously known by the common name, Bliss Rapids Snail, is described. These genera do not appear closely related either to one another or to other North American Hydrobiidae.

INTRODUCTION

Among the large freshwater molluscan fauna of the United States, prosobranch snails of the family Hydrobiidae compose one of the most diverse groups, totaling about 170 described species. Although the state of knowledge of these minute animals has greatly increased in the past 25 years through the combined efforts of several researchers, much work remains to be done, including assessment of the taxonomic status and relationships of poorly known nomina and treatment of a large undescribed fauna.

In the northwestern United States, generic diversity of hydrobiids is low, and relatively few described species are known. Perhaps the most significant unresolved question pertaining to the local described fauna involves the status of *Bythinella hemphilli.* Pilsbry's original placement of this species in *Bythinella,* which is otherwise known only from Europe (Bănărescu, 1990:342), has long been questioned, and two other generic assignments have been offered. Most recent compilations treat this snail as *incertae sedis* (i.e., Burch & Tottenham, 1980:130; Burch, 1989:130). An undescribed fauna of uncertain diversity also occurs in this region and includes a federally listed species from the Snake River of Idaho, commonly known as the Bliss Rapids Snail, which has been treated in the literature as an undescribed genus, based on the unpublished studies of

Taylor (1982). Recent fieldwork in this region has permitted large collections of these two snails, and laboratory studies have suggested that these represent new genera, which we describe below.

MATERIALS AND METHODS

Institutional repositories of examined specimens are indicated by the following abbreviations: ANSP, Academy of Natural Sciences, Philadelphia; UF, Florida Museum of Natural History, Gainesville; and USNM, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Anatomical study was of alcohol-preserved snails that had been relaxed with menthol crystals and fixed in dilute (about 4%) formalin. Inorganic shell material was removed by soaking specimens in Bouins solution or hydrochloric acid. Animals were dissected in dilute Bouins solution. Specimens were first examined entire, after which the visceral coil was separated from the proximal portion of the animal by tearing between the anterior edge of the style sac and the kidney/pericardium. The pallial roof then was torn from the head-foot, flattened out, and pinned. The female glandular oviduct and associated structures were examined from the left side. The RPG ratio is defined as length of the pleuro-supraesophageal connective divided by the sum of lengths of supraesophageal ganglion, pleuro-supraesophageal connective, and right pleural ganglion (Davis et al., 1976:263). Anatomical illustrations were prepared from camera lucida drawings.

Shell, opercula, and radula were cleansed in commercial bleach (CLOROX), rinsed in water, and then studied and photographed using a Hitachi S-570 Scanning Electron Microscope (SEM). Animals were dried using a Denton DCP-1 Critical Point Drier and studied with SEM to ascertain ciliation patterns on dorsal surfaces of tentacles and penis. Whole mounts of penes were prepared by staining in hematoxylin followed by dehydration, clearing, and mounting in balsam. Serial sections were cut at 4 μm and stained with hematoxylin and eosin. Morphological characters were selected, in part, from those listed by Ponder et al. (1993).

SYSTEMATIC TREATMENT

Superfamily Rissooidea Gray, 1847

Family Hydrobiidae Troschel, 1857

Subfamily Lithoglyphinae Troschel, 1857

Pristinicola Hershler, Frest, Johannes, Bowler & Thompson, gen. nov.

Type species: *Bythinella hemphilli* Pilsbry, 1890: monotypy.

Etymology: Latin *pristinus,* pristine, and *cola,* dweller (Masculine [per ICZN Article 30[a][i]]); referring to occurrence of this snail in undisturbed habitats.

Diagnosis: Shell small to medium-sized, narrowly-conic, smooth, whorls near flat to moderately convex, with umbilicus absent or weakly rimate. Aperture simple; inner lip complete; peristome thickened within. Protoconch about 1.5 whorls, finely wrinkled. Operculum thickened, horny, red-brown, paucispiral, with attachment scar margin thickened along inner edge and large attachment scar callus. Radula with central teeth having a single pair of basal cusps; cusp formula of central teeth, (4–5)–1–(4–5); lateral teeth, 3–1–(4–5). Stomach without posterior appendix and with single opening to digestive gland. Cephalic tentacles with fairly heavy, uniform ciliation. Animal pale except for black eyespots. Penis narrow-elongate, without accessory lobes or glands. Female capsule gland with enclosed ventral channel and three distinct glandular zones.

Remarks: Despite the "*Bythinella*-like" shape of their shells, these animals clearly do not belong either to this genus or, more generally, to the subfamily Emmericiinae, as that group is diagnosed, in part, by a penis having accessory glands and lobes, and absence of a female seminal receptacle (Radoman, 1983; Hershler et al., 1990).

Pristinicola and the genus described below share with numerous other freshwater genera a penis lacking lobes or large glands, female capsule gland with the ventral channel completely enclosed, and direct development. The relationships of the various members of this group, both to one another and to other hydrobiids, are poorly understood, although it is likely that these snails were derived from primitive brackish-water or estuarine members of the family (Ponder, 1988b). Of these taxa, several genera of fluviatile snails with large, globose shells from North America, South America, and Europe compose a compact group that has been accorded subfamily status (Lithoglyphinae) by some workers. However, none of the diagnostic character states of the subfamily listed by Thompson (1984) can be considered unequivocal synapomorphies, and the group could represent a polyphyletic assemblage of convergent forms, or a paraphyletic subset of a clade having broader habitat and shell form diversity. (The latter was recently suggested by Hershler & Thompson [1990], who broadened the concept of the "subfamily" by inclusion of several North American genera of subterranean snails.)

Of the eight diagnostic features of the Lithoglyphinae listed by Thompson (1984:123), each of our two new genera only possesses three such features: both lack a posterior appendix of the stomach and have a simple penis; ***Pristinicola*** has basal cusps originating from the face of the central radular tooth; and the genus described below has spiral sculpture on the protoconch. All four of the above features are in fact widely distributed among other genera of the family. Note also that the penis of our snails does not closely conform to that of lithoglyphines, which approximates a broad, flat blade and is perhaps the key character state defining this group. In light of the above, it may be premature to assign our two new genera to a particular hydrobiid subfamily. We expect that a com-

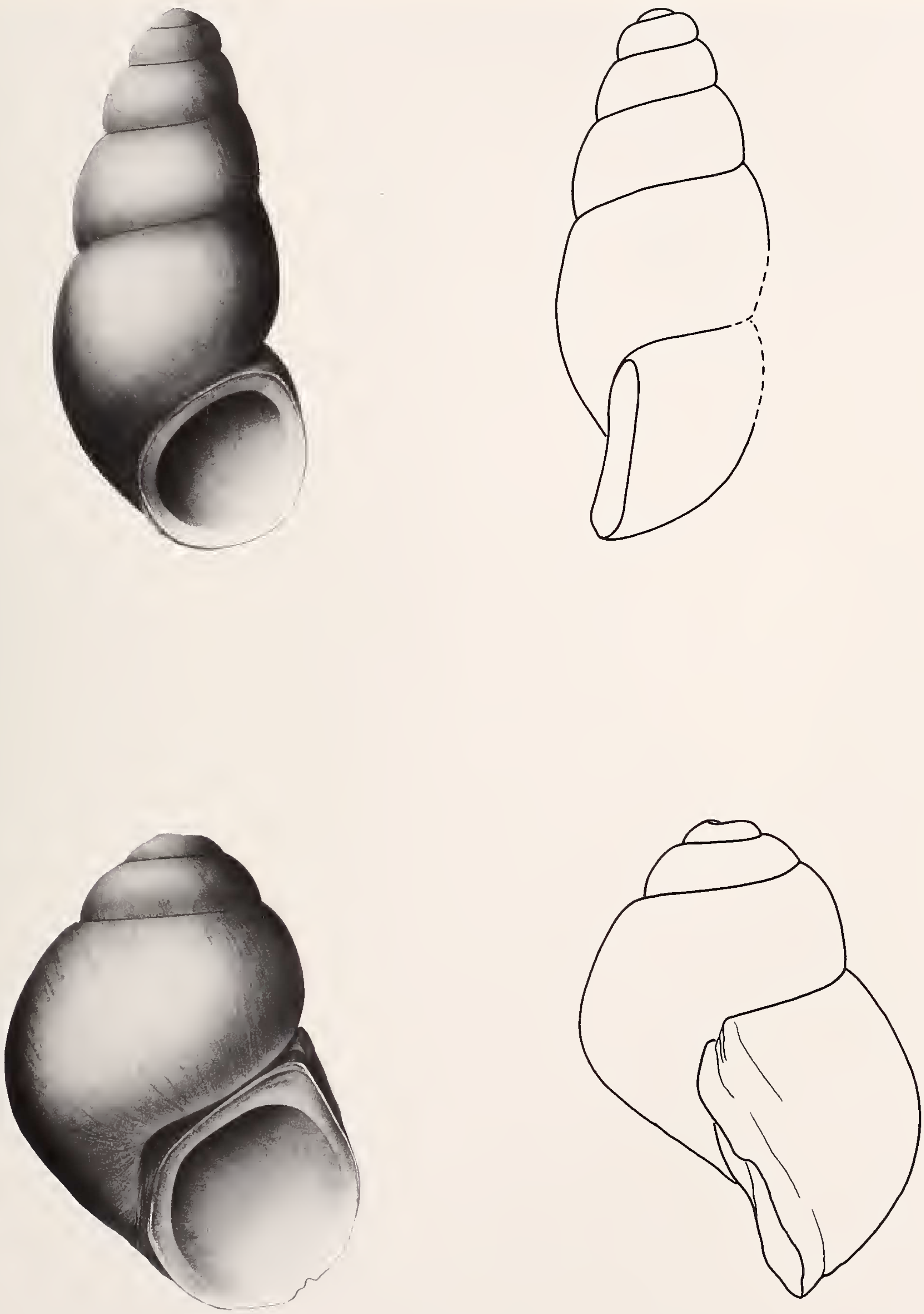

Figure 1

Lectotype, ***Pristinicola*** *hemphilli,* ANSP 31176, shell height, 2.7 mm (top row); holotype, ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov., USNM 860583, shell height, 2.45 mm (bottom row).


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prehensive anatomical survey of "lithoglyphine" taxa will lead to a better resolution of these problems.

Neither of our two new genera is closely similar to any other genus of North American Hydrobiidae. ***Pristinicola*** differs from the genus described below by numerous characters, including its narrower shell, wrinkled protoconch microsculpture, uniform pattern of tentacle ciliation, elongate salivary glands, relatively shorter radula, larger basal cusps on the central radula teeth, strongly developed anterior pedal mucous gland, fingerlike ctenidial filaments, strongly undulating penial duct, three distinct capsule gland zones, and presence of a bursa copulatrix.

Pristinicola *hemphilli* (Pilsbry, 1890)

(Figures 1 [top row], 2–7)

Bythinella hemphilli Pilsbry, 1890:63 (Lectotype [*fide* Baker, 1964:173; Richardson et al., 1991:67], ANSP 31176) (Figure 1 [top row]). Hannibal, 1912:186 (as synonym of *Paludestrina protea*). Clench & Turner, 1962:64. Baker, 1964:173. Anderson & Pratt, 1965:13. Anderson et al., 1966:704. Turgeon et al., 1988:60. Richardson et al., 1991:67.

P[*aludestrina*]. *hemphilli.* Pilsbry, 1899:122.

Paludestrina hemphilli. Walker, 1918:137. Henderson, 1924: 191. Henderson, 1929:166.

Hydrobia hemphilli. Henderson, 1936a:138. 1936b:277.

"*Bithynella*" *hemphilli.* Taylor, 1975:94.

"*Bythynella*" *hemphilli.* Burch & Tottenham, 1980:130 (fig. 320). Burch, 1989:130 (fig. 320).

Description: Shell (Figures 1 [top row], 2) narrowly-conic, almost pupiform; clear-white; length, 1.7–3.1 mm; total whorls 4.25–5.50. Apex blunt; protoconch about 1.5 whorls, finely wrinkled (Figure 4a), often eroded. Teleoconch whorls near flat to moderately convex, with shallow sutures; rarely with adapical shoulder or subsutural angulation. Teleoconch sculpture of weak collabral growth lines, often accompanied by numerous faint spiral striae. Aperture ovate-elongate, rounded or expanded below, rounded or slightly angled above. Inner lip complete, fairly thick, especially adapically, slightly reflected, adnate or very slightly separated from body whorl. Outer lip slightly thickened, straight or slightly curved, usually opisthocline, sometimes orthocline. Umbilicus (usually) absent or weakly rimate. Periostracum tan-light brown, often covered by dark, thick deposits. Shell measurements are in Table 1.

Operculum (Figure 3) horny, fairly thick, ovate, red-brown; nucleus eccentric; dorsal surface unfrilled. Attachment scar margin usually strongly thickened along inner edge, with weaker scar along outer edge. Attachment scar callus fairly large, raised.

Table 1

Shell measurements of ***Pristinicola*** *hemphilli.* WH, number of whorls; SL, shell length; SW, shell width; LBW, length of body whorl; AL, aperture length; AW, aperture width.

	WH	SL	SW	LBW	AL	AW
Lectotype	5.0	2.73	1.29	1.68	0.89	0.89
Paralectotype	5.0	2.57	1.29	1.62	0.85	0.84
Paralectotype	5.0	2.48	1.17	1.54	0.81	0.84
USNM 874627, $n = 9$						
Mean	5.0	2.42	1.21	1.52	0.85	0.86
SD	0.004	0.12	0.08	0.06	0.06	0.03
USNM 874424, $n = 9$						
Mean	4.9	2.32	1.12	1.43	0.77	0.80
SD	0.2	0.17	0.07	0.11	0.05	0.06
USNM 874184, $n = 9$						
Mean	4.5	2.84	1.55	2.01	1.11	1.13
SD	0.1	0.15	0.07	0.10	0.05	0.05
USNM 874626, $n = 5$						
Mean	5.0	2.46	1.16	1.47	0.85	0.84
SD	0.2	0.19	0.07	0.09	0.06	0.06
USNM 758255, $n = 9$						
Mean	4.9	2.73	1.37	1.73	0.95	1.02
SD	0.2	0.25	0.09	0.13	0.08	0.09

Tentacle ciliation fairly heavy, of generally uniform nature (Figure 4b–d). Distal tip of tentacle without elongate setae. Snout slightly longer than tentacles, about as long as wide, with well-developed distal lobes (in preserved material). Eyelobes absent. Foot ovate-elongate; anterior end slightly convex, with well-developed lateral wings; posterior end rounded. Anterior mucous gland of separate glands; central gland about as long as adjacent units. Animal pale except for black eyes.

Buccal mass small relative to snout; jaws present. Salivary glands elongate. Dorsal folds of esophagus simple.

Radular ribbon about 0.85 × 0.08 mm, with approximately 85 rows of teeth; ribbon with medium-sized coil behind buccal mass. Central radular tooth (Figure 5a, b) broadly trapezoidal, with strongly indented dorsal edge. Lateral angles short. Basal process narrow; basal sockets deep. Central cusp pointed, up to twice as long as lateral cusps; lateral cusps, four to five. Basal cusp single, large, arising from outer portion of tooth face. Lateral tooth (Figure 5c–e) with central cusp flanked by three inner cusps and four to five outer cusps; cusps pointed. Basal

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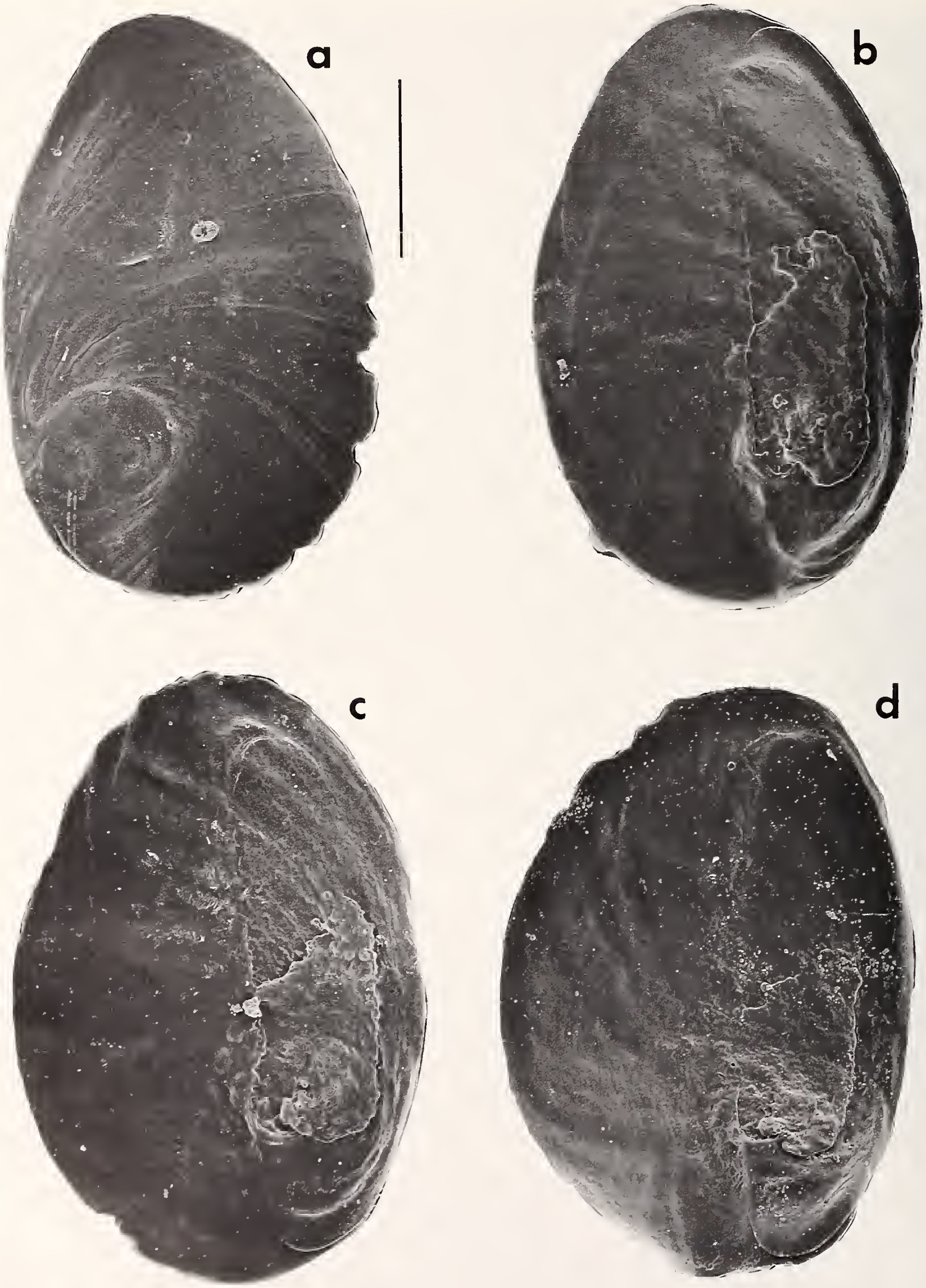
Figure 2

Scanning electron micrographs of shells of ***Pristinicola*** *hemphilli.* a. paralectotype, ANSP 368405, shell height, 2.7 mm. b, c. USNM 874184. d. UF 45976. e. USNM 874424. f, i. USNM 874440. g, h. USNM 874429. All photographs are printed to the same scale.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cusp of lateral tooth well developed; lateral wing about twice as long as cutting edge. Marginal teeth (Figure 5c–f) with small cusps (inner tooth, 16–22; outer, about 23) and weakly developed wings on inner sides.

Stomach chambers poorly differentiated, but appearing about equal in length; posterior appendix absent. Stomach proper about one and one-half times as long as style sac, with single opening to digestive gland. Rectum without arch in pallial cavity; fecal pellets usually oriented longitudinally. Anus positioned near mantle edge, slightly anterior to anterior end of capsule gland.

Mantle edge simple. Organs and structures of pallial cavity shown in Figure 6a. Ctenidium extending to pericardium to slightly posterior to mantle edge; efferent vein short. Filaments about 16, short, finger-shaped, with near central apex. Osphradium broadly ovate with thickened margin, about 20% of ctenidium length, centered slightly posterior to middle of ctenidial axis. Hypobranchial gland poorly developed, near smooth. Kidney with about third of length in pallial roof. Renal gland weakly developed, longitudinal. Renal aperture small, weakly differentiated. Body spaces with very little connective tissue.

Testis, one whorl, composed of broad, vertical, dorsally branched lobes connected ventrally by narrow vas efferens. Testis filling about half of length of visceral coil behind stomach and extending over posterior stomach chamber. Vas deferens exiting from ventral testis near anterior edge. Seminal vesicle small coiled mass underneath anteriormost testis. Prostate gland of complex histology, elongate, bean-like, with third to slightly less than half of length in pallial roof. Prostate gland elongate oval in section; wall of medium thickness all around; lumen narrow, simple. Pallial vas deferens exiting slightly behind anterior end of prostate gland. Pallial vas deferens loosely embedded in connective tissue on pallial roof; posterior section without coil, but curving onto columellar muscle; anterior section straight, on pallial floor in connective tissue.

Penis (Figures 4e, f, 6b) originating well behind left tentacle; narrow-elongate, slightly tapered distally, without lobes; small relative to head, extending only slightly anterior to mantle edge. Basal portion expanded, with few deep folds; penis otherwise simple or with scattered folds. Distal tip of penis (Figure 4f) tapering, with small terminal papilla. Penial duct strongly undulating; opening terminal, simple. Distal penis with scattered bunches of cilia.

Ovary simple sac filled with about 10 oocytes, 1.0 whorl, filling slightly less than half of the visceral coil behind the stomach, and very slightly overlapping the posterior stomach chamber. Distal female genitalia shown in Figure 6c, d. Glandular oviduct of complex histology. Capsule gland simple, as long or slightly longer than albumen gland, composed of very short, clear, posterior section; amber, deeply creased middle section; and long, amber-clear, anterior section. Lateral walls of capsule gland thick; ventral wall thin. Genital aperture small, subterminal pore without anterior vestibule. Albumen gland simple, white, with about 25% of length in pallial roof. Coiled oviduct large, fairly thick, smooth, bound in connective tissue; composed of initial anterior bend followed by tight, circular twist. Bursa copulatrix large, non-muscular, strongly reflexed, with short proximal portion and distal portion extending from just posterior to albumen gland forward over much of dorsal albumen gland. Lumen of bursa copulatrix containing fluid and digested sperm. Bursal duct positioned near ventral edge of albumen gland, fairly short, slightly narrower than proximal bursa copulatrix, opening to oviduct slightly anterior to coiled portion. Seminal receptacle about half as long as bursa copulatrix, broadly ovate, with fairly thickened muscular coat; positioned along ventral edge but largely posterior to albumen gland, overlapped dorsally by bursa copulatrix, oblique or transverse relative to long axis of albumen gland. Lumen of seminal receptacle containing oriented sperm. Seminal receptacle duct about third as long and slightly narrower than sac, opening to oviduct just posterior to opening of bursal duct.

RPG ratio 36%. Cerebral and pedal commissures elongate.

Type locality: Near Kentucky Ferry, Snake River, Washington. This site has never been precisely located (see Henderson, 1936a), but may have been in reference to the Kentuck Trail, which extended from the Snake River in Washington northeast to the Spokane Bridge along the Idaho border (see Freeman, 1954). (Alternatively, Hemphill could have been referring to Central Ferry, an old town on the Snake River in Whitman County, Washington, which was the site of one of the earliest established ferries on the Washington Snake River, and along the old route to Lewiston and Spokane.) There were at least five ferry crossings along a 24 km reach of the Snake River near the origin of the Kentuck Trail: Lyons, Texas, Kentuck, Penawawa, and Central ferries. The Kentuck Ferry was also called the Ruark-Davidson Ferry, Blackfoot Ferry, and Angell Ferry. The exact location of this ferry is difficult to ascertain, as crossing places depended in part on season and local river conditions. Furthermore, there

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Figure 3

Scanning electron micrographs of opercula of ***Pristinicola*** *hemphilli*, USNM 874184. a. Dorsal operculum, bar = 250 μm. b–d. Ventral opercula, bar = 231 μm.

Figure 4

Photographs and scanning electron micrographs of protoconconch, head, and penis of ***Pristinicola** hemphilli*, USNM 874184. a. Protoconch, bar = 120 μm. b. Critical point dried head, bar = 0.43 mm. c. Dorsal surface of critical point dried left tentacle, bar = 176 μm. d. Dorsal surface of right tentacle, scale as in c. e. Whole mount of penis, bar = 0.25 mm. f. Distal tip of critical point dried penis, bar = 38 μm.

Figure 5

Scanning electron micrographs of radula of ***Pristinicola*** *hemphilli*. a. Central radular teeth, USNM 874184, bar = 10 μm. b. Central radular teeth, UF 45971, bar = 5 μm. c–e. Lateral and marginal teeth, USNM 874184, bars = 27 μm, 12 μm, 23.1 μm. f. Outer marginal teeth, USNM 874184, bar = 12 μm.

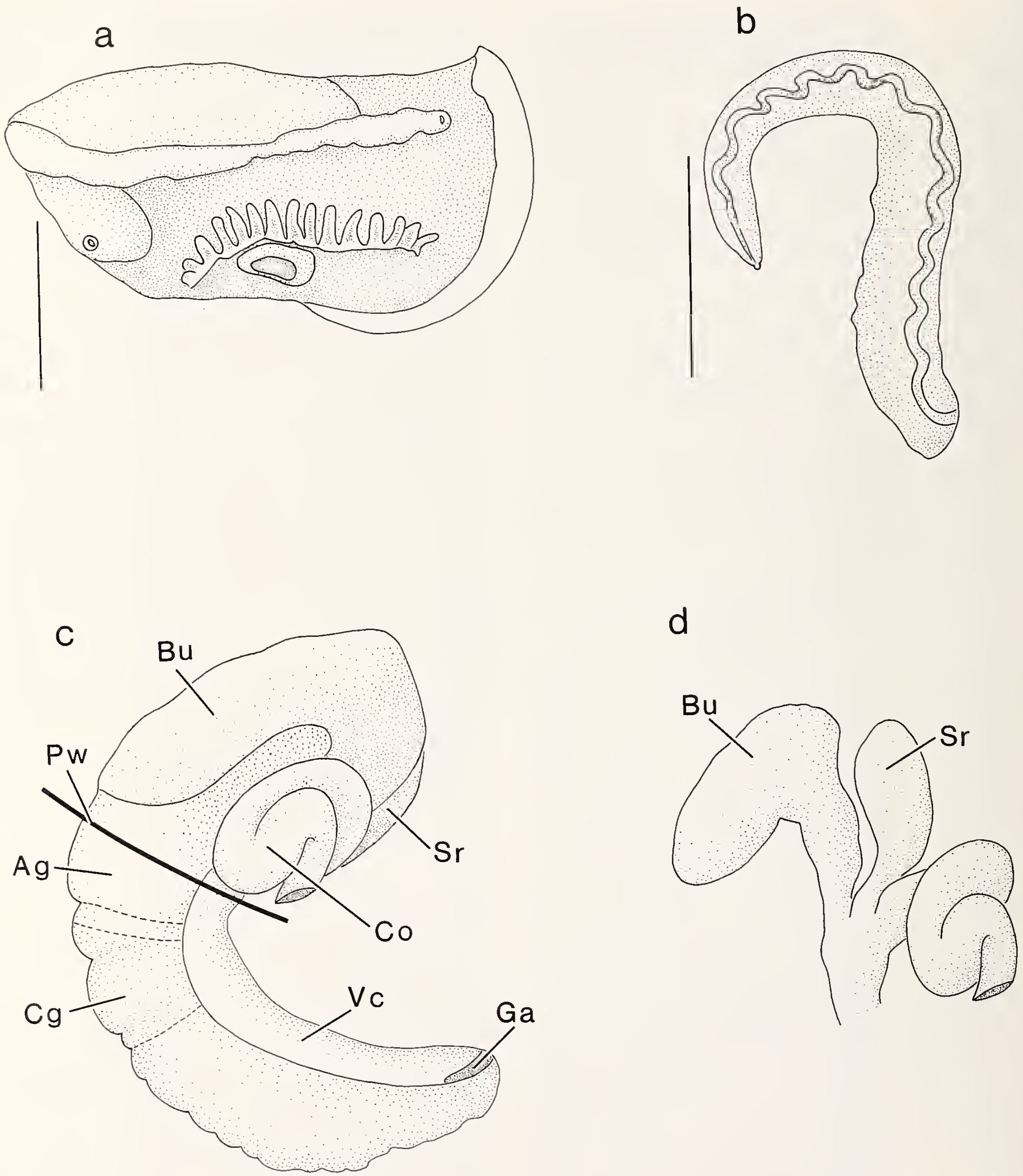

Figure 6

Anatomy of ***Pristinicola*** *hemphilli*, USNM 874184. a. Contents of pallial cavity, bar = 0.25 mm. b. Penis, bar = 0.5 mm. c. Distal female genitalia, left side, scale as in b. d. As in c, but with albumen gland removed and coiled oviduct shifted to completely expose seminal receptacle and bursa copulatrix. Ag, albumen gland; Bu, bursa copulatrix; Cg, capsule gland; Co, coiled oviduct; Ga, genital aperture; Pw, pallial wall; Sr, seminal receptacle; Vc, ventral channel.

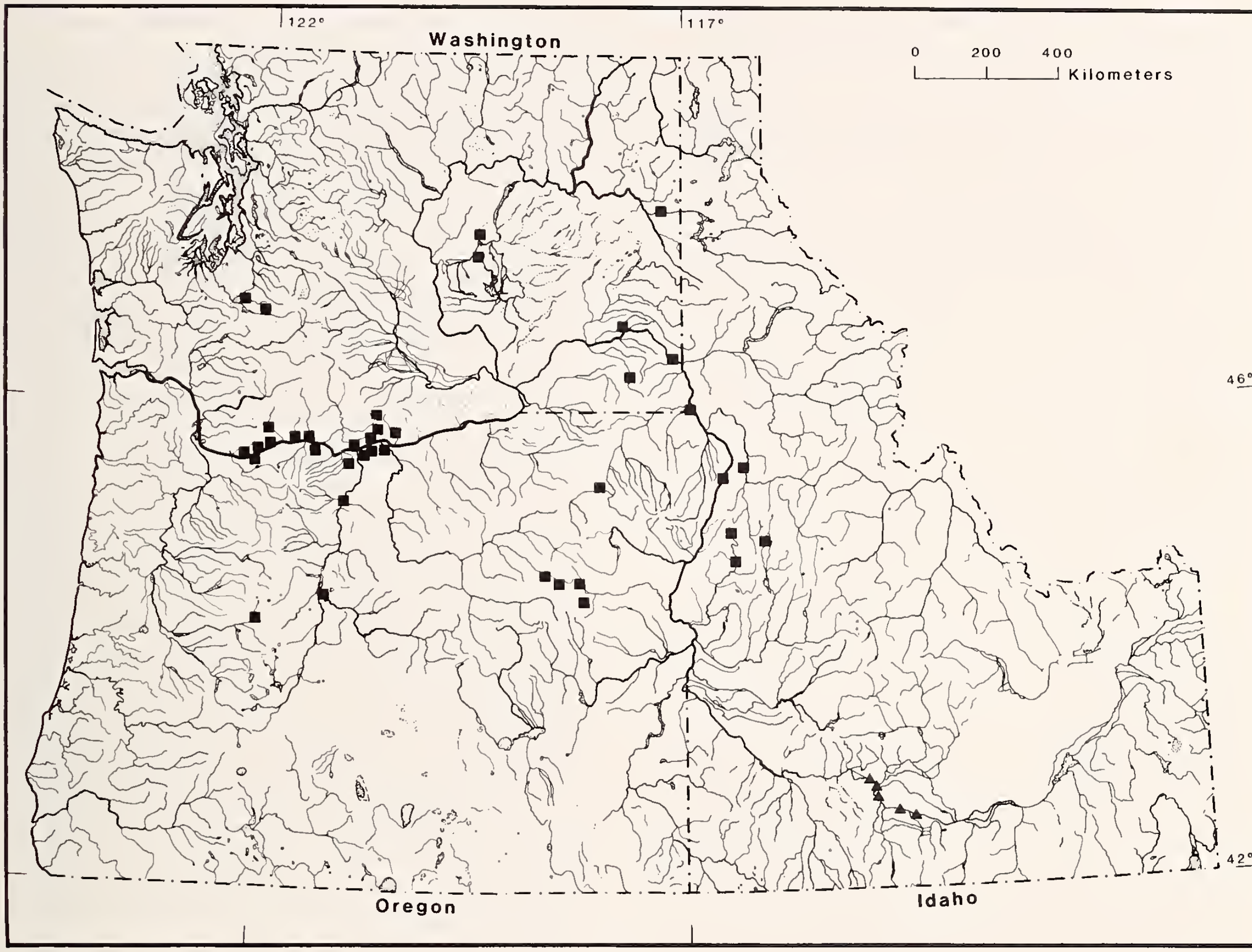

Figure 7

Distribution of ***Pristinicola*** *hemphilli* (squares) and ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov. (triangles). Symbols may refer to more than one locality.

are springs along the north side of the Snake River Canyon wall in the presumed vicinity of all five probable ferry sites, and a few springs on the south side as well. Specimens from two such sites (USNM 874426, USNM 874627) closely resemble the type material.

Distribution: Lower Snake-Columbia River basin of Idaho, Oregon, and Washington; minor Pacific Coastal drainages of Washington (Figure 7).

Ecology: ***Pristinicola*** *hemphilli* is found in permanent cold springs and strongly spring-fed creeks; in both cases most often near the source. These snails are generally absent from larger springs, often are highly abundant in very small spring seeps, but vary widely in occurrence and abundance among spring types. Animals sometimes occur in only one of an identical-appearing set of springs, or will be abundant in one and rare in adjacent sites of similar size, flow, substrate, etc. Frequently the snail will only occur in one of several sets of springs found in a particular drainage.

This species usually lives on cobbles, but may also be found on rock faces. The substrate lithology generally is basalt. Snails are rarely found on mud, silt, plant debris, or living epiphytes. In a few cases, they were found in interstitial habitat among gravel, mostly in small springs with little flow. The animals appear to be strongly photophobic.

This species appears to have an annual cycle, with most adults dying off in late winter–early spring (after egg-laying) regardless of weather conditions. Newly hatched juveniles begin to appear in April, and are most common during this or the next month. Eggs are laid singly in very small capsules, often attached to sheltered sides or undersides of cobbles.

This species mostly lives in association with *Pisidium* (*Neopisidium*) *insigne*; *Fossaria* (*B.*) *dalli* also is often present. In the Columbia Gorge, the snail tends to be absent from springs in which pleurocerid snails and/or *Lyogyrus* cf. *greggi* are abundant.

Remarks: Typically, the shell is elongate (SL/SW, 2.4), with a tapered apex, and aperture height about one-third shell height (Figure 2a, d–i). However, shells from a few populations in the Washington–Oregon Blue Mountains and from nearby western Idaho are relatively low and broad, with a blunt apex and aperture more than one-third shell height (Figure 2b, c). Mature size (shell height) also varies from population to population, even when adults with identical whorl numbers are compared (e.g., Figure 2f, h); and in a few samples, adult size was bimodal. (Note, in this regard, that we did not evaluate sexual dimorphism in shell size or shape.)

Pristinicola** hemphilli* has an unusually broad distribution among western American hydrobiids. Most sites are in Columbia Basin tributaries or immediately adjacent drainages, a region in which other hydrobiid genera (*Amnicola, Fluminicola, Lyogyrus, Pyrgulopsis*) are present but represented by few species. The genus appears to be absent from the Columbia drainage in northern Washington and Idaho. Known sites are south of the area in these states strongly affected by Late Pleistocene (Wisconsinan) glaciation. As yet, there are no sites in the Coast ranges or Rocky Mountains. ***Pristinicola is also absent from the Snake River Plain, i.e., the area occupied by Pliocene Lake Idaho, but present in the lower Snake system, which is believed to have been a part of the Columbia drainage since at least the Miocene. Most of the region of snail occurrence is comparatively young geologically. It is underlain by Miocene–Pliocene Columbia River Group flood basalts, and in great part was subjected to severe scour from the Pleistocene Lake Missoula Floods. Dispersal thus has likely been comparatively recent.

There is no fossil record for this genus either within its present distribution or in Lake Idaho sediments. A possibly related form occurs in the Eocene Princeton Group of British Columbia (*Micropyrgus camselli* Russell, 1957); and somewhat similar shells have also been noted from poorly preserved material from the Cretaceous Fort Union Group of North Dakota (*Micropyrgus minutulus* Meek, 1876) and the Oldman Formation (Cretaceous) of southern Alberta (*Hydrobia higdoni* Russell, 1937).

Material Examined:

IDAHO. Adams County: ANSP 82343, spring at Council (Washington County [now Adams County]; ANSP 82368, Price Valley, Weiser Canyon; USNM 874184, Unnamed spring, Price Valley, about 4.8 km northwest of HWY 95, sec. 12, T. 19 N, R. 1 W (used for anatomical description); USNM 874445, unnamed springs just south of Hells Canyon Dam, on east side of river, NE ¼ sec. 21, T. 22 N, R. 3 W. Idaho County: USNM 874425, Logged-Up Springs, Phillips Ridge, above Cow Creek, NE ¼ sec. 6, T. 25 N, R. 1 E. Valley County: mountain near Big Payette Lake [now called Payette Lake, near McCall].

OREGON. USNM 531057. Baker County: USNM 874410, Mammoth Spring at Mammoth Spring Campground, Elk Creek, off FS2640, SE ¼ sec. 30, T. 13 S, R. 36 E; USNM 874422, Horse Spring, South Sister Creek, just south of Oregon Campground, on US 26, NE ¼ sec. 7, T. 12 S, R. 36 E. Grant County: USNM 874429, Big Springs, SW ¼ sec. 1, T. 12 S, R. 35 E; USNM 874430, unnamed spring above Clear Creek, on Clear Creek Road (FS147), SE ¼ sec. 10, T. 12 S, R. 35 E. Hood River County: USNM 874419, springs west of Oxbow Salmon Hatchery, NE ¼ sec. 7, T. 2 N, R. 8 E; USNM 874437, unnamed roadside spring east of Columbia Gorge Work Center, NW ¼ sec. 4, T. 2 N, R. 8 E. Jefferson County: USNM 874412, Opal Springs, northernmost spring, along Crooked River, NE ¼ sec. 33, T. 2 S, R. 12 E. Lane County: USNM 758255, South Fork McKenzie River, about 15 miles southeast of town at McKenzie Bridge. Multnomah County: USNM 854174, base of waterfall from unnamed creek, Pillars of Hercules, SE ¼ sec. 21, T. 1 N, R. 5 E; USNM 874411, unnamed spring east of Wahkeena Falls, on south side of railroad tracks, Benson State Park, SE ¼ sec. 12, T. 1 N, R. 5 E; USNM 874418, unnamed spring in gully east of Bridal Veil Creek, SE ¼ sec. 22, T. 1 N, R. 5 E; USNM 874427, unnamed spring adjacent to Bridal Veil Creek, NW ¼ sec. 25, T. 1 N, R. 5 E; USNM 874435, Bridal Veil Creek to south of bridge on east side of creek, NW ¼ sec. 26, T. 1 N, R. 5 E; USNM 874447, Wahkeena Creek, Columbia Gorge. Sherman County: USNM 854176, Frank Fulton Canyon, 2nd alcove on south side, east side spring complex, SE ¼ sec. 19, T. 2 N, R. 16 E; USNM 874438, Helms Springs, Helms Canyon, SW ¼ sec. 35, T. 3 N, R. 17 E; USNM 874439, small unnamed spring west of Biggs Junction, SW ¼ sec. 18, T. 2 N, R. 16 E; USNM 874442, unnamed side spring in Scott Canyon, south of Rufus, NE ¼ sec. 5, T. 2 N, R. 17 E; USNM 874443, Frank Fulton Canyon, 1st alcove on south side, east spring, SE ¼ sec. 19, T. 2 N, R. 16 E; USNM 874446, unnamed spring at mouth of Fox Canyon (west side), SW ¼ sec. 32, T. 3 N, R. 18 E. Union County: USNM 874624, Hale Spring, Mt. Emily, Blue Mountains, NE ¼ sec. 8, T. 1 S, R. 38 E; USNM 874433, unnamed spring on NFD100, off Owlsley Canyon Road, SE ¼ sec. 18, T. 2 S, R. 38 E. Wasco County: USNM 854173, unnamed spring above Eightmile Creek, NE ¼ sec. 15, T. 1 N, R. 14 E; USNM 854177, Oak Springs, near site of Tuscan, SW ¼ sec. 17, T. 4 S, R. 14 E; USNM 854178, unnamed spring above Eightmile Creek, NE ¼ sec. 9, T. 1 N, R. 14 E; USNM 874415, unnamed spring tributary to Eightmile Creek, SW ¼ sec. 15, T. 11 N, R. 14 E; USNM 874423, unnamed spring above Eightmile Creek, NE ¼ sec. 9, T. 1 N, R. 14 E; USNM 874428, Mosier Springs, Mosier Creek, NE ¼ sec. 12, T. 2 N, R. 11 E; USNM 874440, unnamed spring tributary to Eightmile Creek, SE ¼ sec. 9, T. 1 N, R. 14 E.

WASHINGTON. ANSP 31176 (lectotype), ANSP 368405 (paralectotypes), near Kentucky Ferry; ANSP 123162, spring on headwaters of Palouse River, Spokane Plain. Asotin County: USNM 854538, spring in unnamed tributary to Steptoe Canyon on east side of Colton Road, NW ¼ sec. 4, T. 11 N, R. 45 E; USNM 874421, unnamed spring at USGS gauging station north of Heller Bar, Hells Canyon, NE ¼ sec. 12, T. 7 N, R. 46 E. Columbia County: spring above Tucannon River and west of Tucannon Road in unnamed tributary northeast of Camp William T. Wooten State Park, NW ¼ sec. 21, T. 9 N, R. 41 E. Grant County: USNM 874416, spring on east side of Lenore Lake, Grand Coulee, NW ¼ sec. 13, T. 23 N, R. 26 E; USNM 874626, springs tributary to Rocky Ford Creek at Trout Lodge Hatchery, NW ¼ sec. 16, T. 21 N, R. 27 E. Klickitat County: USNM 854175, unnamed spring west of Sam Hill Bridge, SW ¼ sec. 5, T. 27 N, R. 16 E; USNM 854180, unnamed spring and spring run in Brooks Memorial State Park, NE ¼ sec. 3, T. 5 N, R. 17 E; USNM 874413, unnamed spring complex along WA14 above John Day Dam, SE ¼ sec. 19, T. 3 N, R. 17 E; USNM 874417, unnamed spring tributary to North Luna Creek, adjacent to Oak Flat Road, SE ¼ sec. 13, T. 4 N, R. 17 E; USNM 874424, unnamed springs (4; collection from easternmost) west of Hood River Bridge, SW ¼ sec. 24, T. 3 N, R. 10 E; USNM 874432, unnamed spring and spring run tributary to Rock Creek, near Newell Road crossing, NW ¼ sec. 20, T. 4 N, R. 19 E. Pierce County: ANSP 89303, upper valley of Nesqually [sic: Nisqually] River near Ashford; USNM 854171, unnamed spring on east side (center) of Ohop Lake, above Ski Park Road, SE ¼ sec. 3, T. 16 N, R. 4 E. Skamania County: UF 45971, Government Mineral Springs, 14 miles north-northwest of Carson; UF 45976, Beaver Pond, 10 miles north-northwest of Carson; USNM 854172, unnamed spring east of Galligan Spring and adjacent to WA14, NW ¼ sec. 30, T. 3 N, R. 10 E; USNM 854179, Franz Road springs, easternmost spring above WA14, NW ¼ sec. 4, T. 1 N, R. 6 E; USNM 854181, Galligan Spring, run just east of base of cutoff road adjacent to WA14, NW ¼ sec. 30, T. 3 N, R. 10 E; USNM 874409, unnamed spring and run tributary to Woodward Creek, near Beacon Rock, NE ¼ sec. 35, T. 2 N, R. 6 E; USNM 874414, Franz Road springs, easternmost spring from railroad tracks to WA14, NW ¼ sec. 4, T. 1 N, R. 6 E; USNM 874420, unnamed spring on west side of WA14 at site of Cruzatt, NE ¼ sec. 11, T. 1 N, R. 5 E; USNM 874436, unnamed spring complex north of west end of Spring Creek National Fish Hatchery, adjacent to WA14, SW ¼ sec. 22, T. 3 N, R. 10 E; USNM 874441, unnamed spring tributary to Greenleaf Creek near WA14 bridge, T. 2 N, R. 7 E; USNM 874444, unnamed spring and run tributary to Greenleaf Creek at Moffett Springs Road bridge, T. 2 N, R. 7 E. Spokane County: USNM 874431, unnamed spring above Spokane River near Petit Road exit, adjacent to Spokane Falls Community College Bridge, NW ¼ sec. 12, T. 50 N, R. 43 E. Whitman County: USNM 874426, spring tributary to unnamed creek above Central Ferry along WA 127, NW ¼ sec. 23, T. 14 N, R. 40 E; USNM 874627, spring on west side of Penawawa Road along unnamed creek tributary to Snake River, SE ¼ sec. 11, T. 14 N, R. 40 E.

Taylorconcha Hershler, Frest, Johannes, Bowler & Thompson, gen. nov.

Type species: ***Taylorconcha serpenticola*** sp. nov.; monotypy.

Etymology: Latin *concha,* shell (Feminine). Honoring Dwight Taylor, for his discovery and early work on this genus and, more generally, in recognition of his lifetime of fieldwork and research on the systematics, biology, and biogeography of the freshwater molluscan fauna of western North America. The common name, Bliss Rapids Snail, has been used for this taxon (Taylor, 1982; USDI, 1984, 1990, 1991a, b, 1992).

Diagnosis: Shell small to medium-sized, globose to ovate-conic, smooth, whorls slightly convex, with umbilicus small or absent. Aperture large, simple; inner lip usually incomplete. Protoconch about 1.5 whorls, lined with fine spiral lines. Operculum horny, paucispiral, attachment scar margin thickened along a portion of its length; attachment scar callus variably developed. Radula elongate, with central teeth having a single pair of basal cusps; cusp formula of central teeth, (4–5)–1–(4–5); lateral teeth 2–1–(2–3). Stomach without posterior appendix and with single opening to digestive gland. Cephalic tentacles ciliated with two to three narrow, longitudinal bands. Penis elongate–vermiform, without accessory lobes or glands. Female capsule gland with enclosed ventral channel and two distinct glandular zones. Bursa copulatrix absent.

Remarks: Unusual features of this genus include the elongate radula, weakly developed anterior pedal mucous gland, and absence of female bursa copulatrix, which is unique among North American hydrobiids, with the exception of several minute, highly reduced cave snails.

Taylorconcha serpenticola Hershler, Frest, Johannes, Bowler & Thompson, sp. nov.

(Figures 1 [bottom row], 7–12)

Bliss Rapids Snail. Taylor, 1982:1. Bowler, 1991:175. Langenstein & Bowler, 1991:185. Bowler & Frest, 1992: 30. Frest & Bowler, 1992:45. Frest & Johannes, 1992: 16. Frest & Johannes, 1993a:5. Frest & Johannes, 1993b:5.

Genus and species undescribed [Bliss Rapids Snail]. USDI, 1984:21673. USDI, 1991b:58818.

Family Hydrobiidae, sp. nov. [Bliss Rapids Snail]. USDI, 1990:51931. USDI 1991a:50550. USDI 1992:59245.


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Undescribed genus (Bliss Rapids Snail). Frest & Bowler, 1993:54.

Etymology: Latin *serpens,* snake, and *cola,* dweller; referring to the distribution of this species in the Snake River and associated springs.

Description: Shell (Figures 1 [bottom row], 8a–c) globose to ovate-conic; clear-white; length, 2.0–4.0 mm; total whorls, 3.5–4.5. Apex blunt; protoconch about 1.5 whorls, near planispiral; sculpture of numerous low spiral lines (Figure 9a, b). Teleoconch whorls slightly convex, with shallow sutures, sometimes strongly shouldered or with sub-sutural shelf. Teleoconch sculpture of strong collabral growth lines, usually accompanied by adapical striae. Aperture large, ovate, rounded below, slightly or strongly angled above. Inner lip complete in largest specimens, otherwise incomplete or a thin glaze; thickened, often greatly so adapically, slightly reflected; usually adnate, rarely slightly separated from body whorl. Outer lip thin to fairly thick, prosocline, often slightly sinuate. Umbilicus absent–small. Periostracum very light tan to dark brown-red. Shell measurements are in Table 2.

Operculum (Figure 8d–i) horny, thin, ovate, thin, light amber; nucleus eccentric; dorsal surface weakly frilled. Attachment scar margin thickened, sometimes broadly so, between nucleus and inner edge; sometimes also thickened along entire outer edge. Attachment scar callus small, weakly to rather strongly developed and raised.

Tentacle ciliation of two to three narrow longitudinal bands (Figure 9c–e). Distal tip of tentacle without elongate setae. Snout squat, near square; distal portion tapered, with well-developed lobes; tentacles stubby, considerably shorter than snout (in preserved material). Eyelobes absent. Foot near-circular, anterior end slightly convex, without lateral wings; posterior end slightly tapered, rounded. Anterior mucous gland very weakly developed, consisting of one or few very small, central units. Animal variably pigmented, ranging from pale except for black eyes to colored with epithelial black pigment as follows: tentacles darkened, especially along sides, except for distal tips; snout fairly light, with pigment heaviest on sides and distally; foot pale–light, with pigment mostly along anterior edge; opercular lobe pale–light, pigment mostly along inner edge; neck pale–very light; pallial roof and visceral coil dark, near-uniform.

Buccal mass medium-sized, extending from near base of tentacles to tip of snout; jaws present. Salivary glands narrow, twisted, short, extending only to cerebral ganglia. Dorsal folds of esophagus simple.

Table 2

Shell measurements of ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov. WH, number of whorls; SL, shell length; SW, shell width; LBWLBW, length of body whorl; AL, aperture length; AW, aperture width.

	WH	SL	SW	LBW	AL	AW
Holotype	3.5	2.45	1.78	2.16	1.31	1.09
Paratypes, $n = 9$						
Mean	3.5	2.32	1.82	2.07	1.25	1.15
SD	0.0	0.12	0.13	0.12	0.07	0.05
USNM 874590, $n = 10$						
Mean	3.75	2.93	2.08	2.42	1.41	1.32
SD	0.29	0.39	0.14	0.27	0.12	0.09

Radular ribbon elongate, about 0.12 × 1.8 mm, with several coils alongside esophagus behind buccal mass, with about 115 rows of teeth. Central radular tooth (Figure 10a, b) broadly trapezoidal, with straight dorsal edge. Lateral angles short, strongly curved, strongly differentiated from tooth face by prominent neck. Basal process medium-broad; basal sockets deep. Central cusp pointed, up to twice as long as lateral cusps; lateral cusps, four to five. Basal cusp single, minute, arising from intersection between tooth face and lateral angle. Lateral tooth (Figure 10c–e) with broad central cusp flanked by two inner cusps and two to three outer cusps; cusps pointed. Basal cusp of lateral tooth well developed; lateral wing about one and half times as long as cutting edge. Marginal teeth (Figure 10c–f) with small, narrow cusps (inner tooth, 20–22; outer, about 25); lateral wings absent on teeth.

Stomach chambers about equal in length; posterior appendix absent. Stomach about one and half times as long as style sac, with single opening to digestive gland. Rectum without arch in pallial cavity; fecal pellets oriented longitudinally. Anus positioned near mantle edge, anterior to anterior end of capsule gland.

Mantle edge simple. Organs and structures of pallial cavity shown in Figure 11a. Ctenidium extending to slightly posterior to mantle edge; efferent vein short. Filaments about 17, fairly well developed, short, slightly broader than high, with central apex. Osphradium narrowly ovate, po-

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Figure 8

Scanning electron micrographs of shells and opercula of ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov. a, b. Paratypes, USNM 874588, shell height (a), 2.2 mm. c. USNM 874591. d, e. Dorsal operculum, USNM 874588, bar = 0.27 mm. f–i. Ventral operculum, USNM 874588, bars = 250 μm, 0.27 mm, 0.30 mm. Photographs of shells are printed to the same scale. e is printed to the same scale as d; g is printed to the same scale as f; h is printed to the same scale as d.


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sitioned slightly anterior to middle of ctenidial axis. Hypobranchial gland with well-developed folds, especially anteriorly, but fairly thin. Kidney with slightly less than third of length in pallial roof. Renal gland very weakly developed, longitudinal. Renal aperture small, whitened. Body space with little connective tissue.

Testis, 0.75 whorl, composed of few broad lobes connected ventrally by vas efferens. Testis filling about half of length of visceral coil behind stomach and overlapping posterior stomach chamber. Vas deferens exiting from ventral testis about quarter of length posterior from anterior tip. Seminal vesicle a large mass underneath anterior third of testis. Prostate gland of complex histology, small, thin, ovate, with entire length posterior to pallial cavity wall, elongate oval in section; wall of medium thickness all around; lumen narrow, simple. Pallial vas deferens exiting from ventro-right lateral side slightly behind anterior end of prostate gland. Pallial vas deferens simple, embedded in connective tissue on pallial roof; anterior section simple, on pallial floor in connective tissue.

Penis (Figures 9e–g, 11b) originating near midline of neck, well behind tentacles; elongate-vermiform, tapering along entire length; large relative to head. Basal portion slightly expanded; penis without folds, but longitudinally striated (Figure 9f). Distal tip of penis tapering. Penial duct near straight; opening terminal, simple (Figure 9g). Distal penis with scattered bunches of cilia.

Ovary small, orange sac of less than 0.25 whorl containing about six oocytes, positioned behind the stomach and filling less than a quarter of the visceral coil behind the stomach. Distal female genitalia shown in Figure 11c. Glandular oviduct of complex histology. Capsule gland simple, shorter than albumen gland, composed of short, yellow posterior section and whiter anterior section. Lateral walls of capsule gland thick; ventral wall thin. Genital aperture small, subterminal pore borne on slightly raised papilla, without anterior vestibule. Albumen gland simple, greenish, with 20–25% of length in pallial roof. Coiled oviduct fairly small, thick, smooth, bound in connective tissue; composed of single, tight, circular-horizontal loop. Bursa copulatrix absent. Seminal receptacle filling 15–20% of albumen gland length; narrow, tubular; positioned obliquely on and shallowly imbedded in posterior half of albumen gland and extending to near posterior edge of gland. Lumen of seminal receptacle containing oriented sperm. Seminal receptacle duct poorly distinguished from body, but of similar length and width, opening to oviduct at proximal end of coil near ventral edge of albumen gland.

Cerebral ganglia with spotted black pigment. RPG ratio about 23%; right pleural and supraesophageal ganglia weakly differentiated. Cerebral and pedal commissures elongate.

Type material: Thousand Springs (north springs), Gooding County, Idaho, SW ¼ sec. 8, T 8 S, R 14 E. Holotype, USNM 860583; paratypes, USNM 874588 (used for anatomical description), UF 194616.

Distribution: Historically known from a short reach of main stem Middle Snake River and associated springs, between Twin Falls and Indian Cove Bridge, Idaho (Figure 7). The highly disjunct, upstream record reported by Pentec Environmental, Inc. (1991) requires verification.

Ecology: ***Taylorconcha serpenticola*** occurs in both spring and riverine habitat. The snail is not found in impoundments, areas subject to major depth fluctuations, still or stagnant environments, lentic habitats, warm-water areas, typical river edge habitats, or areas with mud, sand, or fine gravel substrate. The species occurs only in flowing water, but is usually absent from whitewater areas. River populations now occur only in areas with strong spring influence, generally from springs emerging in the river bed. Such colonies tend to parallel river banks some distance from the normal low water mark, unless influx from bordering springs is present. We have found this taxon generally in water at 15–16°C.

Taylorconcha serpenticola is restricted to stable rocky substrates in areas with exceptional water quality. As most of the area inhabited by this snail has basalt as bedrock, lithologic preferences, if any, are uncertain. Taylor (1982) suggested that large cobbles and boulders with vescicular texture were preferred. We have found the snail on liths down to 1 cm in maximum dimension, with no apparent upper limit, and observed similar or even higher densities on smooth rocks compared to those with pumicelike textures. This species typically occurs only on the exposed lateral sides and undersides of rocks. The snails do not burrow in sediments, and are not found on rock surfaces in contact with soft sediment. Aside from occasional waifs, no live specimens were observed on mud or larger vegetation. Snails were found on well-secured deadwood, but

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Figure 9

Photographs and scanning electron micrographs of protoconch, head, and penis of ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov., USNM 874588. a, b. Protoconch, bars = 150 μm, 120 μm. c. Critical point dried left tentacle, bar = 75 μm. d. Critical pointed dried right tentacle, bar = 86 μm. e. Critical point dried head and penis, bar = 0.27 mm. f. Whole mount of distal penis, bar = 0.25 mm. g. Critical point dried distal tip of penis, bar = 17.6 μm.

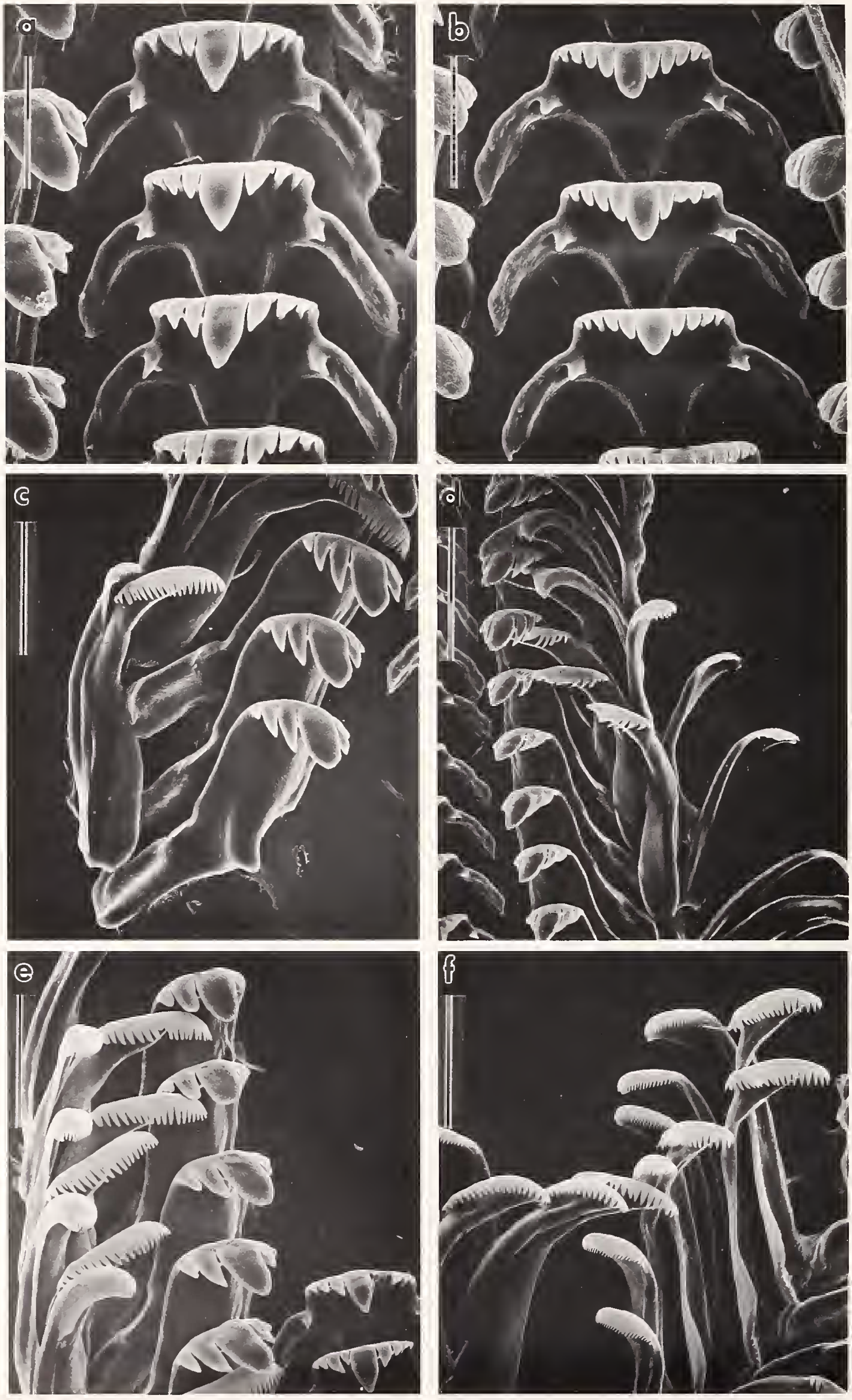

Figure 10

Scanning electron micrographs of radula of ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov., USNM 874588. a, b. Central radular teeth, bars = 15 μm, 17.6 μm. c–e. Lateral, marginal teeth, bars = 27 μm, 38 μm, 25 μm. f. Marginal teeth, bar = 27 μm.

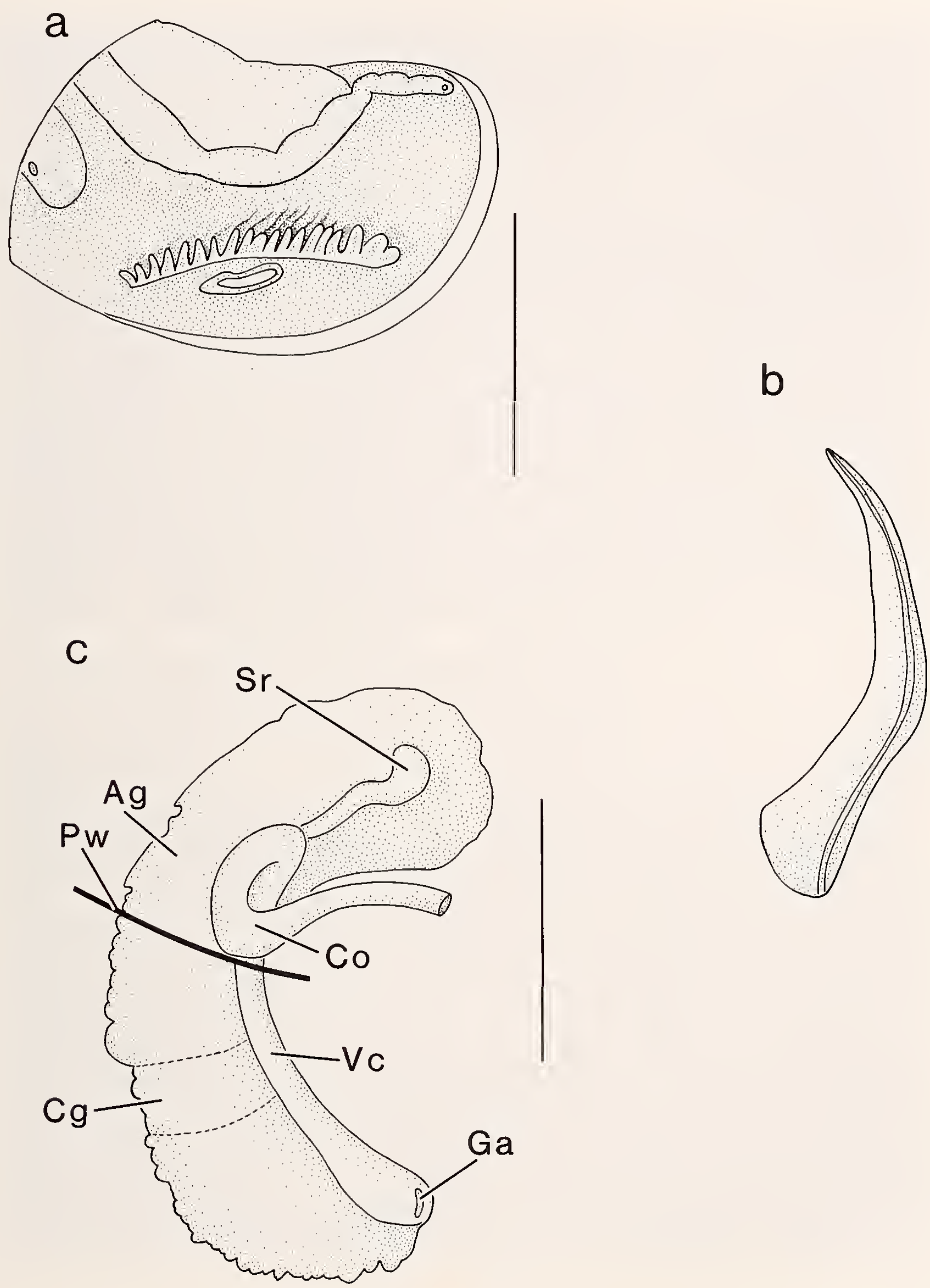

Figure 11

Anatomy of ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov., USNM 874588. a. Contents of pallial cavity, bar = 1.0 mm. b. Penis, scale as above. c. Distal female genitalia, left side, bar = 0.5 mm. Ag, albumen gland; Cg, capsule gland; Co, coiled oviduct; Ga, genital aperture; Pw, pallial wall; Sr, seminal receptacle; Vc, ventral channel.

seldom on loose pieces, and densities on any wood surface appeared quite low.

In spring-dwelling populations, egg laying apparently takes place from approximately December–March, while in the mainstem middle Snake River colonies, this occurs in January and February. Eggs are laid singly, in very small capsules attached to the bottom or sides of rocks in protected areas also inhabited by adults. Eggs were not seen on the shells of living members of this or other local snail species. As with some other hydrobiids, most of the

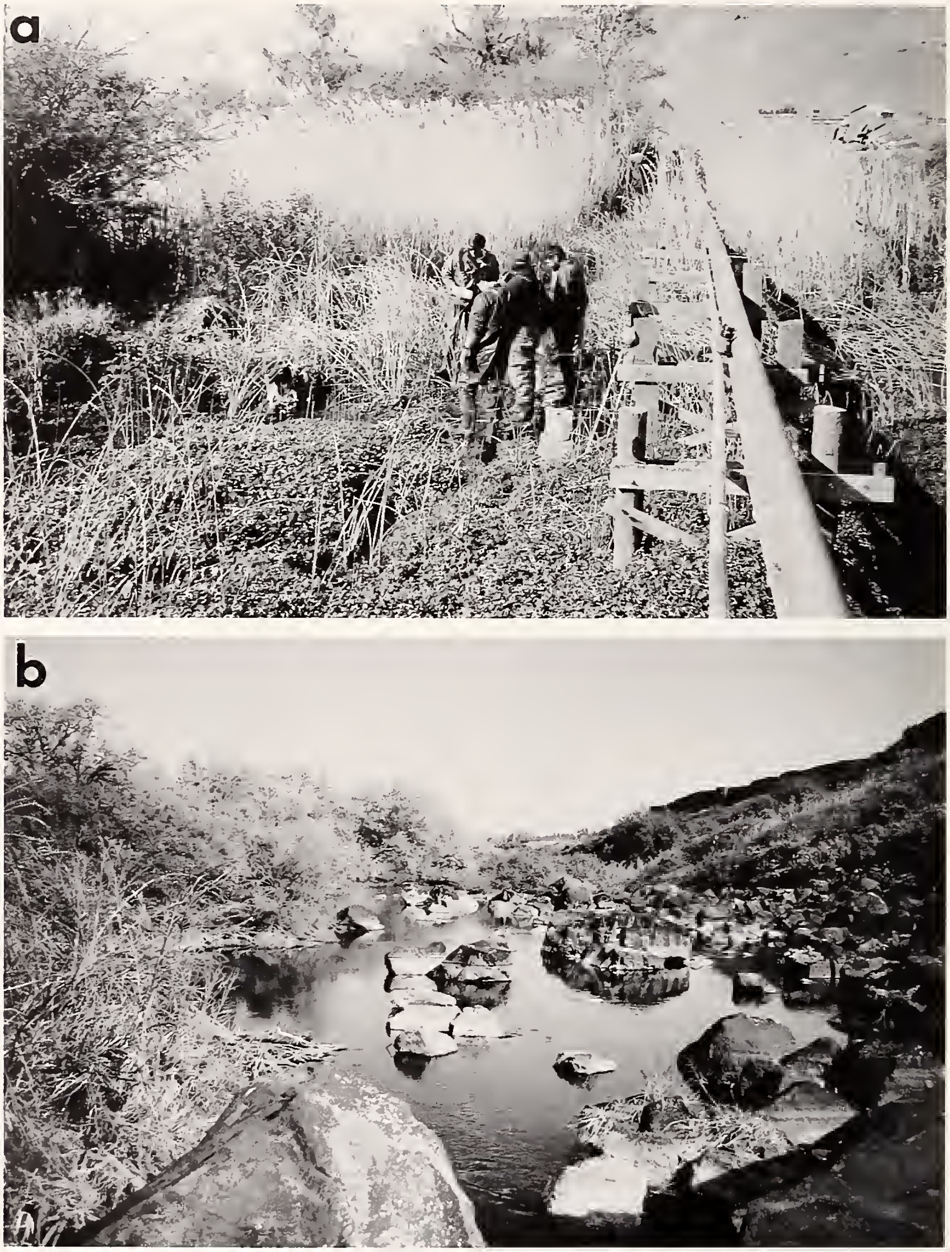

Figure 12

Photographs of Thousand Springs "North," Gooding County, Idaho, type locality of ***Taylorconcha serpenticola*** Hershler, Frest, Johannes, Bowler & Thompson, gen. et sp. nov. a. Upper portion of spring outflow, which is crossed by The Nature Conservancy pipeline. b. Lower portion of outflow.

adult population appears to be replenished annually, as particularly evident in the mainstem middle Snake River populations.

At relatively undisturbed sites, the most frequent associated mollusks are other cold-water forms such as *Fluminicola hindsi, Pyrgulopsis idahoensis, Vorticifex effusus, Physa natricina, Lanx* n. sp., and *Fisherola nuttalli* as well as *Physella* (*P.*) *gyrina*. ***Taylorconcha serpenticola*** is the numerically dominant mollusk at most near-pristine sites: river localities now are often dominated by the introduced New Zealand mudsnail *Potamopyrgus antipodarum*. In many small spring or waterfall sites, our snail may be the only mollusk present.

Remarks: There are two morphs of ***Taylorconcha serpenticola***. One (Figure 8a, b) has shells with orange-red to pale orange periostracum, moderately convex whorls, fairly attenuate apex, strong collabral growth lines, thick parietal lip, and dark epithelial body pigment. The other morph (Figure 8c) has a nearly colorless shell, more rounded whorls, blunt apex, weak growth lines, thin parietal lip, and weaker body pigment in most populations. The two morphs may represent ecotypes, with the orange form typical of strongly spring-influenced mainstem colonies and relatively large springs, and the pale morph confined to mainstem river colonies with less obvious spring influence, and relatively shallow springs; but note that there are exceptions to these habitat generalizations. Most orange morph colonies occur in areas where encrusting red algae are common, suggesting that diet may be related to these color differences. The amount of shell variation in this snail does not exceed that recorded for several other western American hydrobiid species (e.g., *Pyrgulopsis micrococcus*: see Hershler & Sada, 1987; Hershler, 1989) and thus we only recognize a single taxon, although it would be desirable to obtain genetic data to further evaluate this problem.

Taylorconcha is known from the Late Pliocene (Blancan) Glenns Ferry Formation, Gooding County; Early Pleistocene Bruneau Formation, Owyhee County; and from Late Pleistocene and probable Holocene deposits in Gooding County (Frest & Johannes, 1992), and is one of several surviving endemic relicts of Pliocene Lake Idaho or its Pleistocene successors. This lake formed as a result of tectonic activity in the Snake River Plain as early as 3.5 million years before the present (Y.B.P.) and persisted in some form into the Pleistocene, possibly to as late as 600,000 Y.B.P. Exact configuration of Lake Idaho changed through time, as a number of different Snake River Group basalt flows erupted during the lake's history, covering various areas of the Snake River Plain. However, the basic limits were approximately to the western Idaho–eastern Oregon border upstream from Hells Canyon and east to a point near American Falls, Idaho (Taylor, 1985; Malde, 1991). The mollusk fauna of Lake Idaho was exceptional and highly endemic, totalling over 80 taxa (Taylor *in* Malde & Powers, 1962; Taylor *in* Malde, 1972).

A few of the Lake Idaho endemics survive to the present. These occur only in a relatively short, unpolluted segment of the mainstem Snake River and in the extensive alcove spring complexes in the same reach. Increasing human settlement and activities have reduced the mainstem occurrences of these mollusks to a few isolated populations found mostly in a 38 km segment of the Snake River (the Wiley Reach, Hagerman Reach, and adjacent areas), and to a few populations in the few relatively undisturbed alcove spring complexes. The type locality of ***Taylorconcha serpenticola*** (Thousand Springs Preserve) is one of the best remaining examples. Water quality in the middle Snake River drainage has declined drastically in recent years, due to effects of irrigation, aquaculture, dairy farms, and hydroelectric projects, as well as increasing upstream irrigation, and urban usage and development (USDI, 1992). Such considerations led Taylor (1982) to encourage federal listing of the snail as Endangered in his status report. After much further study (see Frest & Johannes, 1992, 1993b), the species was listed as Threatened (USDI, 1992).

In the last five years, new threats to the survival of ***Taylorconcha*** and other middle Snake River endemics have developed. The most important of these involves the parthenogenic New Zealand hydrobiid snail *Potamopyrgus antipodarum* (also known as *P. jenkinsi*), which was introduced into the Idaho Snake system in, or just subsequent to, 1985 and is now present in enormous numbers in the Snake River from at least Twin Falls to C. J. Strike Reservoir. By 1987, *P. antipodarum* had begun to invade the alcove springs, including the Thousand Springs Preserve (Taylor, 1987; Bowler, 1991; Langenstein & Bowler, 1991; Frest & Johannes, 1992). As yet, the species has had limited effects on ***Taylorconcha*** populations in springs. It is now the most abundant mollusk at river sites, and appears to negatively impact ***Taylorconcha serpenticola,*** minimally by crowding behavior during the frequent periods when peak loading at several hydroelectric dams affects the river. In the middle Snake River area, *P. antipodarum* is most successful in moderately polluted habitats and has made limited inroads into more pristine locales. This species has also invaded and spread throughout southern Australia and parts of western Europe (Ponder, 1988a).

Material Examined:

IDAHO. Elmore County: USNM 874590, Snake River at Clover Creek inflow, SW ¼ sec. 8, T. 5 S, R. 11 E; USNM 874591, USNM 874192, Snake River at Bancroft Springs, NE ¼ sec. 4, T. 6 S, R. 11 E. Gooding County: Thousand Springs, T. 8 S, R. 14 E: USNM 874463, USNM 874472, USNM 874491, USNM 874493, USNM 874496, Minnie Miller Lake and associated springs, NW ¼ sec. 8; USNM 874462, USNM 874478, Bridal Veil Springs, NW ¼ sec. 8; USNM 874503, USNM 874451, Minnie Miller Springs, second outlet springs, NW ¼ sec. 8; USNM 874466, USNM 874469, USNM 874473, USNM 874481, USNM 874483, USNM 874492, USNM 874502, USNM 874505, Minnie Miller Springs, first outlet springs, NW ¼ sec. 8; USNM 874467, USNM 874485, USNM 874487, USNM 874490, USNM 874494, USNM 874504, USNM 874592, Thousand Springs North Springs, SW ¼ sec. 8; USNM 874461, USNM 874464, USNM 874484, USNM 874489, USNM 874498, Sculpin Springs, SW ¼ sec. 17; USNM 874468, USNM 874501, springs below Sand Springs creek waterfall, SW ¼ sec. 17; USNM 874448, USNM 874482, USNM 874486, USNM 874488, USNM 874497, USNM 874510, Sand Springs Pool springs, SW ¼ sec. 17; Banbury Springs, NE ¼ sec. 33, T. 8 S, R. 14 E: USNM 874499, far north outlet; USNM 874477, fifth outlet south; USNM 874449, USNM 874471, USNM 874479, USNM 874495, mid-complex sites; USNM 874470, far south outlet; Box Canyon Creek, T. 8 S, R. 14 E; USNM 874474, spring tributary to Box Canyon Creek on south side just above (east) of 1973 diversion pool, NE ¼ sec. 28; USNM 874475, just east of planned Hardy diversion, lower Box Canyon Creek, north side, NW ¼ sec. 28; USNM 874480, small alcove with spring just north of mouth of Box Canyon Creek on Snake River, NW ¼ sec. 28, T. 8 S, R. 14 E; USNM 874500, small alcove with spring above Malad River near junction with Snake River, NW ¼ sec. 35, T. 6 S, R. 13 E; USNM 874465, Niagara Springs at old public access to north of county access road, NE ¼ sec. 10, T. 9 S, R. 15 E; USNM 874586, Birch Creek, just below spring source, SE ¼ sec. 35, T. 6 S, R. 13 E. Twin Falls County: USNM 874450, Snake River on south side, about 180 m west of Bliss Bridge, subaqueous spring, SW ¼ sec. 7, T. 6 S, R. 13 E.

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LITERATURE CITED

Anderson, G. A., G. W. Martin & I. Pratt. 1966. The life cycle of the trematode *Cephalouterina dicamptodoni* Senger and Macy, 1953. Journal of Parasitology 52:704–706.

Anderson, G. A. & I. Pratt. 1965. Cercaria and first intermediate host of *Euryhelmis squamula.* Journal of Parasitology 51:13–15.

Baker, H. B. 1964. Type land snails in the Academy of Natural Sciences of Philadelphia. Part III. Limnophile and thalassophile Pulmonata. Part IV. Land and fresh-water Prosobranchia. Proceedings of the Academy of Natural Sciences of Philadelphia 116:149–193.

Bănărescu, P. 1990. Zoogeography of Fresh Waters. Volume I. General Distribution and Dispersal of Freshwater Animals. AULA-Verlag: Wiesbaden. 511 pp.

Bowler, P. 1991. The rapid spread of the freshwater hydrobiid snail *Potamopyrgus antipodarum* (Gray) in the middle Snake River, Southern Idaho. Desert Fishes Council 21:173–182.

Bowler, P. & T. Frest. 1992. The non-native snail fauna of the middle Snake River, Southern Idaho. Desert Fishes Council 23:28–44.

Burch, J. B. 1989. North American Freshwater Snails. Malacological Publications: Hamburg, Michigan. 365 pp.

Burch, J. B. & J. L. Tottenham. 1980. North American freshwater snails. Species list, ranges and illustrations. Walkerana 1:1–215.

Clench, W. J. & R. D. Turner. 1962. New names introduced by H. A. Pilsbry in the Mollusca and Crustacea. Special Publications of the Academy of Natural Sciences of Philadelphia 4:1–218.

Davis, G. M., V. Kitikoon & P. Temcharoen. 1976. Monograph on "*Lithoglyphopsis*" *aperta,* the snail host of Mekong River schistosomiasis. Malacologia 15:241–287.

Freeman, O. W. 1954. Early wagon roads in the inland empire. Pacific Northwest Quarterly 45:125–130.

Frest, T. & P. Bowler. 1992. The ecology, distribution and status of relict Lake Idaho mollusks and other endemics in the middle Snake River. Desert Fishes Council 23:45–46 (abstract).

Frest, T. & P. Bowler. 1993. A preliminary checklist of the aquatic and terrestrial mollusks of the middle Snake River sub-basin. Desert Fishes Council 24:53–58.

Frest, T. J. & E. J. Johannes. 1992. Distribution and ecology of the endemic and relict mollusc fauna of Idaho TNC's Thousand Springs Preserve. [Unpublished] Report (Contract # IDFO 050291-A) to The Nature Conservancy of Idaho. 291 pp.

Frest, T. J. & E. J. Johannes. 1993a. Mollusc survey of the Auger Falls Project (FERC #4794) reach of the middle Snake River, Idaho. [Unpublished] Report to Idaho Division of Environmental Quality. 35 pp.

Frest, T. J. & E. J. Johannes. 1993b. Mollusc survey of the Minidoka Dam Area, upper Snake River, Idaho. [Unpublished] Report (Contract #1425-22-PG-10-16780) to United States Department of the Interior, Bureau of Reclamation. 36 pp.

Gray, J. E. 1847. A list of the genera of Recent Mollusca, their synonyma and types. Proceedings of the Zoological Society of London 15:129–219.

Hannibal, H. 1912. A synopsis of the Recent and Tertiary freshwater Mollusca of the Californian Province, based upon an ontogenetic classification. Proceedings of the Malacological Society of London 10:112–211.

Henderson, J. 1924. Mollusca of Colorado, Utah, Montana, Idaho and Wyoming. University of Colorado Studies 13:65–223.

Henderson, J. 1929. Non-marine Mollusca of Oregon and Washington. University of Colorado Studies 17:47–190.

Henderson, J. 1936a. Mollusca of Colorado, Utah, Montana, Idaho, and Wyoming—supplement. University of Colorado Studies 23:81–145.

Henderson, J. 1936b. The non-marine Mollusca of Oregon and Washington—supplement. University of Colorado Studies 23:251–280.

Hershler, R. 1989. Springsnails (Gastropoda: Hydrobiidae) of Owens and Amargosa River (exclusive of Ash Meadows) drainages, Death Valley system, California-Nevada. Proceedings of the Biological Society of Washington 102:176–248.

Hershler, R., J. R. Holsinger & L. Hubricht. 1990. A revision of the North American freshwater snail genus *Fontigens* (Prosobranchia: Hydrobiidae). Smithsonian Contributions to Zoology 509:1–49.

Hershler, R. & D. W. Sada. 1987. Springsnails (Gastropoda: Hydrobiidae) of Ash Meadows, Amargosa Basin, California-Nevada. Proceedings of the Biological Society of Washington 100:776–843.

HERSHLER, R. & F. G. THOMPSON. 1990. *Antrorbis breweri,* a new genus and species of hydrobiid cavesnail (Gastropoda) from Coosa River Basin, northeastern Alabama. Proceedings of the Biological Society of Washington 103:197–204.

LANGENSTEIN, S. & P. BOWLER. 1991. On-going macroinvertebrate analysis using the Biotic Condition Index and the appearance of *Potamopyrgus antipodarum* (Gray) in Box Canyon Creek, southern Idaho. Desert Fishes Council 21: 183–194.

MALDE, H. E. 1972. Stratigraphy of the Glenns Ferry Formation from Hammett to Hagerman, Idaho. United States Geological Survey Bulletin 1331D:1–19.

MALDE, H. E. 1991. Quaternary geology and structural history of the Snake River Plain, Idaho and Oregon. Pp. 251–281. *In:* R. B. Morrison (ed.), Quaternary Non-glacial Geology: Conterminous United States. Geological Society of America: Boulder, Colorado, Geology of America, K-2. 672 pp.

MALDE, H. E. & H. A. POWERS. 1962. Upper Cenozoic stratigraphy of Western Snake River Plain, Idaho. Geological Society of America Bulletin 73:1197–1220.

MEEK, F. B. 1876. A report on the invertebrate Cretaceous and Tertiary fossils of the Upper Missouri Country. Report of United States Geological Survey of the Territories 9:1–629.

PENTEC ENVIRONMENTAL, INC. 1991. Distribution survey of five species of molluscs, proposed for Endangered status in the Snake River, Idaho during March 1991. Final [unpublished] report, Pentec Project No. 00070-001, prepared for Idaho Farm Bureau, Boise, Idaho. 22 pp.

PILSBRY, H. A. 1890. Notices of new Amnicolidae. Nautilus 4:63–64.

PILSBRY, H. A. 1899. Catalogue of the Amnicolidae of the western United States. Nautilus 12:121–127.

PONDER, W. F. 1988a. *Potamopyrgus antipodarum*—a molluscan colonizer of Europe and Australia. Journal of Molluscan Studies 54:271–285.

PONDER, W. F. 1988b. The Truncatelloidean (= Rissoacean) radiation—a preliminary phylogeny. Pp. 129–166. *In:* W. F. Ponder (ed.), Prosobranch Phylogeny. Malacological Review Supplement 4.

PONDER, W. F., G. A. CLARK, A. C. MILLER & A. TOLUZZI. 1993. On a major radiation of freshwater snails in Tasmania and eastern Victoria: a preliminary overview of the *Beddomeia* group (Mollusca: Gastropoda: Hydrobiidae). Invertebrate Taxonomy 5:501–750.

RADOMAN, P. 1983. Hydrobioidea a superfamily of Prosobranchia (Gastropoda) I Sistematics. Serbian Academy of Sciences and Arts, Department of Sciences, Monographs 57: 1–256.

RICHARDSON, C. L., R. ROBERTSON, G. M. DAVIS & E. E. SPAMER. 1991. Catalog of the types of Recent Mollusca of the Academy of Natural Sciences of Philadelphia. Pt. 6. Gastropoda. Mesogastropoda: Viviparacea, Valvatacea, Littorinacea, Rissoacea (Pt. 1: Adeorbidae, Amnicolidae, Anabathridae, Assimineidae, Barleeidae, Bithyniidae, Caecidae, Cingulopsidae, Elachisinidae, Falsicingulidae). Tryonia 23:1–243.

RUSSELL, L. S. 1937. New non-marine Mollusca from the Upper Cretaceous of Alberta. Transactions of the Royal Society of Canada 31:61–66.

RUSSELL, L. S. 1957. Mollusca from the Tertiary of Princeton, British Columbia. National Museum of Canada, Bulletin 147:84–95.

TAYLOR, D. W. 1975. Index and bibliography of Late Cenozoic freshwater Mollusca of western North America. University of Michigan, Papers on Paleontology 10:1–384.

TAYLOR, D. W. 1982. Status report on Bliss Rapids Snail. [unpublished] Report to United States Fish and Wildlife Service, Portland, Oregon. 8 pp.

TAYLOR, D. W. 1985. Evolution of freshwater drainages and molluscs in western North America. Pp. 265–321. *In:* C. J. Smiley (ed.), Late Cenozoic History of the Pacific Northwest. American Association for the Advancement of Science, Pacific Division: San Francisco. 417 pp.

TAYLOR, D. W. 1987. Thousand Springs Preserve Threatened or Endangered snails. [unpublished] Report to The Nature Conservancy of Idaho. 2 pp.

THOMPSON, F. G. 1984. North American freshwater snail genera of the hydrobiid subfamily Lithoglyphinae. Malacologia 25:109–141.

TROSCHEL, F. H. 1856–1863. Das Gebiss der Schnecken zur Begründung einer Natürlichen Classification. Erster Band. Nicolaische Verlagsbuchhandlung: Berlin. 252 pp.

TURGEON, D. D., A. E. BOGAN, E. V. COAN, W. K. EMERSON, W. G. LYONS, W. L. PRATT, C. F. E. ROPER, A. SCHELTEMA, F. G. THOMPSON & J. D. WILLIAMS. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. American Fisheries Society Special Publication 16:1–277.

UNITED STATES DEPARTMENT OF THE INTERIOR [USDI]. 1984. Endangered and Threatened wildlife and plants; review of invertebrate wildlife for listing as Endangered or Threatened species. Federal Register 49:21664–21675.

UNITED STATES DEPARTMENT OF THE INTERIOR [USDI]. 1990. Endangered and Threatened wildlife and plants; proposed Endangered status for five Idaho aquatic snails. Federal Register 55:51931–51936.

UNITED STATES DEPARTMENT OF THE INTERIOR [USDI]. 1991a. Endangered and Threatened wildlife and plants; reopening of comment period on proposed Endangered status for five mollusks from South Central Idaho. Federal Register 56: 50550–50551.

UNITED STATES DEPARTMENT OF THE INTERIOR [USDI]. 1991b. Endangered and Threatened wildlife and plants; animal candidate review for listing as Endangered or Threatened species. Federal Register 56:58804–58836.

UNITED STATES DEPARTMENT OF THE INTERIOR [USDI]. 1992. Endangered and Threatened wildlife and plants; determination of Endangered or Threatened status for five aquatic snails in South Central Idaho. Federal Register 57:59244–59257.

WALKER, B. 1918. A synopsis of the classification of the freshwater Mollusca of North America, north of Mexico, and a catalogue of the more recently described species, with notes. University of Michigan, Museum of Zoology, Special Publications 6:1–213.